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The blockchain technology and its applications in the financial sector

Bachelor's Thesis
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Abstract of bachelor's thesis

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Abstract

Industries and old ways of doing business have been reshaped or become entirely obsolete due to the new digitalization trends. The current technology to truly revolutionize and disrupt especially industries that rely on trust, such as the financial sector, is the blockchain technology. The core idea of this technology is that it is a public, shared and tamperproof ledger that allows people who do not know or even trust in each other to share information in a trustworthy ledger, where any sorts of immaterial information of value can be stored. This thesis is a literature review that provides a theoretical framework to examine how the blockchain technology affects particularly the financial sector.

As this thesis acknowledges, the blockchain technology has the ability to enhance efficiency, increase transparency, reduce risks when less assets are tied up during transactions and reduce expenditures, such as transaction costs in the financial sector. One of the most ambitious application of the blockchain technology is smart contracts, but there are other applications as well that can benefit the financial sector. The technology has great potential to disrupt the current financial system, but since the technology is still in its initial stage of development, it is too early to say what the blockchain technology will exactly enable. The most extreme hypothesis is that the blockchain technology makes banks unnecessary. However, this thesis argues that the financial institutions are more likely to take advantage of the blockchain technology than to become obsolete because of it.

Keywords blockchain technology, financial sector, smart contracts

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1. Introduction

Information technology has already remarkably disrupted industry and business practices (Jakšič & Marinč, 2015). The Internet on the other hand has created many new ways of doing business and even created new industries that were not even existing a couple of years ago. Who would have thought that the Internet would enable Spotify, Airbnb and Skype? The true catch of the information technology is that it creates entirely new and more effective ways for business and people to co-operate.

The technology one should pay attention to at the moment is the blockchain technology. This fairly new technology will as well as the Internet enable easier, cheaper and more efficient ways of doing business, but also secure insecure ones. The blockchain is mostly known as the technology underlying the virtual crypto-currency bitcoin, but this thesis examines to what else it can be utilized to. Since almost all of the data in today's blockchains are bitcoins, this thesis will briefly analyze what exactly bitcoin is and why it is capable of serving as an alternative currency. Even so, the aim of this thesis is to emphasize that the technology is not restricted to this use only. In fact, bitcoin has been notably criticized and is claimed to be a rather limited application of this technology. The Economist (2016b) points out that it is therefore essential to differ between the specific technology behind the virtual currency bitcoin and the general idea of blockchains. Buterin (2015) on the other hand highlights the difference between private and public blockchains.

In a nutshell, the blockchain is a public, trusted and shared ledger (The Economist, 2016b), which is based on a peer-to-peer network, which means that no one controls it, but it is maintained by thousands of participants (The Economist, 2015). This makes it a shared ledger. The blockchain is public, since the blockchain is available to all the participants (The Economist, 2016b). The information that is recorded in the blockchains cannot be tampered with unnoticed, which on the other hand makes the blockchain a trusted ledger (The Economist, 2015). These characteristics allow the blockchain to transfer information without any intermediaries.

The topics of this thesis include the blockchain technology, its importance, possible applications and challenges. Even though the applications of the blockchain technology have been researched in several studies, it is still unclear what it will enable now and in the future. Malinova and Park (2016) examine e.g. how the securities trading and market design can be reshaped and enhanced by applying the blockchain technology and The Economist (2015) explains how blockchain-based land registries can counteract corruption. Pinna and Ruttenberg (2016) claim in their study that smart contracts, which are one of the most ambitious application of the technology so far, can replace several functions that are currently maintained by necessary post-trade institutions. The one thing to be sure about is the fact that the technology will have significant meaning but probably not in the very near future, since the change to a blockchain-based system will take

time. However, according to Masters (2015), the technology will be as revolutionizing as the Internet was two decades ago. As already mentioned, this thesis goes through applications in a few different areas, but it concentrates particularly on how the financial sector can take advantage of the blockchain technology, since as stated in The Economist (2016b), the technology has the opportunity to disrupt especially industries that rely on trust.

The financial sector is often thought of as a slowly changing, highly conservative and regulated branch. However, the accounting company PWC (2014) argues that banks are currently dealing with enormous and fast happening changes concerning technology as well as regulations and will transform heavily in the next ten years. In order to follow the new trends of the world, banks have to become more willing to adapt to technologies that transform ways of doing business. According to Murray (2016), the blockchain technology will truly revolutionize the financial sector and even make some jobs, such as brokers, disappear. Nevertheless, the technology can simultaneously result in new job opportunities (Murray, 2016). The most extreme hypothesis is that the blockchain technology makes banks unnecessary. However, this thesis argues that the financial institutions are more likely to take advantage of the blockchain technology than to disappear due to it.

Many of the applications that the technology provides require shared standards and co-operation between the actors in the financial sector (The Economist, 2016a). Therefore, this thesis examines briefly the co-operation between the financial technology start-up R3 and a group of approximately 50 financial institutions around the world. The purpose of this co-operation is to develop the blockchain technology and to fasten the adaptation of it to the financial sector. They are together trying to come up with shared standards on how to use this technology, which is surely a challenge in the highly competitive world of finance (The Economist, 2016a). According to Trautman (2016), the blockchain technology has the potential to disrupt and reshape the world of banking, despite of all the challenges it faces.

This thesis concludes that the blockchain technology will reach much further than bitcoin. However, it is too early to say what the blockchain technology will exactly enable and when the blockchain can be implemented to the financial sector, since the development of the technology is in its early stage. Nevertheless, it has great potential to disrupt the current financial system. Without unnecessary and pricey intermediaries in e.g. international payments or securities trading, financial institutions can reduce costs and increase efficiency. Furthermore, since blockchain-based processes tie up less capital, risks are reduced (The Economist, 2016a). The blockchain's transparency as well as reliability on the other hand create faith in the financial system. However, it is also important to emphasize that every piece of information of value is not rational to put in to blockchains, because some services might be more suitable for the blockchains than others. Be that as it may, this thesis argues that the financial institutions would benefit from applying the blockchain technology

to automate international payments and securities trading to begin with, since these have already been proven successful.

1.1 Objective

The objective of this thesis is to give an insight on the core concepts of the blockchain technology and the possible applications of the blockchain technology with emphasis on the financial sector.

1.2 Structure

This thesis is a literature review that provides a theoretical framework to examine how the blockchain technology could affect today's business and industries. It also explains how the use of the technology could e.g. improve efficiency and create faith in the financial system. All of the before mentioned will be done by using already existing literature. The aim of this thesis is to provide a comprehensive understanding of the blockchain technology's possible applications and challenges.

This thesis proceeds in four parts. In the first chapter it introduces the topic and explains the key concepts. The following chapter gives a sufficient comprehension of what the blockchain technology is and why it matters. This thesis goes through how the blockchain technology received attention and why it reaches further than the virtual currency bitcoin. Afterwards it examines briefly the possible applications of the technology and its challenges. This thesis will not go in to detail about the technology's technical description, since that would require almost an investigation on its own. It is undoubtedly an interesting aspect as well and if interested, I recommend strongly examining it further. However, a concise introduction of the technical description is provided in order to understand the potential of the technology.

In the third chapter, the thesis examines how the technology could affect and benefit the financial sector, which is the focus of this thesis. It explores how the financial institutions can reduce risks and expenditures by employing the blockchain technology as well as how the competition between the institutions will transform. Since the blockchain technology is a rather new phenomenon, the amount of research of the effects of the technology in the financial sector is limited. Therefore, the estimations of the possible outcomes are

uncertain and as a result, many of the assumptions of what the blockchain technology may enable in the future financial sector are conclusions made in this thesis.

Finally, the conclusion part provides a summary of this thesis and introduces the main findings along with possible future research.

1.3 Key concepts

BITCOIN is a virtual currency based on the blockchain technology, which enables bitcoin to function as a medium of exchange without involving a trusted intermediary, such as a bank. Virtual currencies are alternatives to fiat currencies and can be used in the same way as cash. Bitcoin is today's most known and used virtual currency.

BLOCKCHAIN TECHNOLOGY is briefly explained a public, distributed and trusted ledger, which is available for everyone. It is also tamperproof, which means that when a piece of information is put in to the blockchain, it cannot be tampered with unnoticed. Technically any kind of intangible information of value can be put in to the ledger. The blockchain technology does not require any trust between its users, which allows making transactions without a third party.

DISTRIBUTED LEDGERS are public databases that no one controls. Instead, they are maintained by several participants. Information is in a distributed ledger stored in thousands of different places rather than concentrated in one place. The blockchain technology is a feature of a distributed ledger.

FIAT CURRENCY is today's most used currency and defined as a technically valueless currency that has been given value by government or law. Notes for instance are an example of a fiat currency, since they are in fact only piece of paper but have gained a certain value.

PEER-TO-PEER NETWORK is a computer network based on nodes, e.g. computers that are maintaining the network worldwide. It is a decentralized network where nodes share information with each other without anyone controlling the network.

2. The blockchain technology

2.1 The core concepts of the blockchain

The blockchain technology came to life by the pseudonym Satoshi Nakamoto (The Economist, 2015). Nakamoto, who is the inventor of the cryptocurrency bitcoin, published in 2008 the study "Bitcoin: A Peer-to-Peer Electronic Cash System". The writer of this study is yet today unknown, but is believed to be a hacker or a group of hackers (Trautman, 2016). Arguably, bitcoin was the world's first decentralized public ledger and it has today gained global status around the world (Pilkington, 2015). However, the success of bitcoin comes from the cryptographic technology underlying it, namely the blockchain technology (Pilkington, 2015). This technology has also recently become a hot topic for researchers and been argued to be an even more revolutionizing phenomenon than bitcoin.

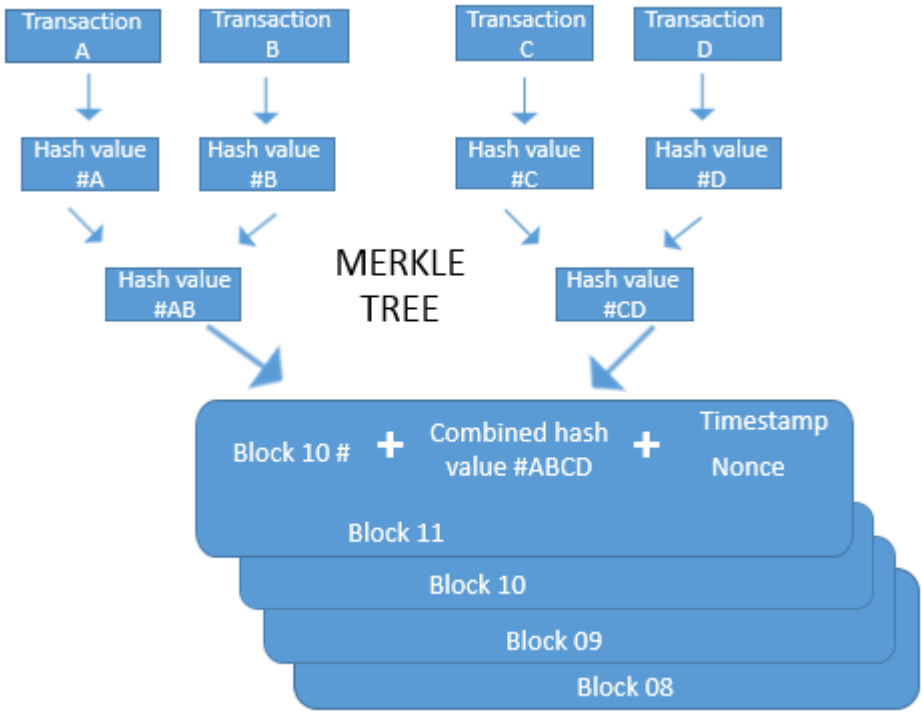
The blockchain is a feature of a distributed ledger, which means that it is not controlled by any single actor, but maintained by several participants (The Economist, 2016a). This allows people who do not know or even have trust in each other to form a trustworthy ledger, where information is recorded (The Economist, 2015). Any kind of immaterial information such as property rights and virtual currency transactions can be stored in these blockchains. The information is available to everyone and tamperproof, which allows the blockchain to be a transparent machine that makes and preserves the truth (The Economist, 2015). The three essential qualities of the blockchain are that it is a shared, trusted and public ledger (The Economist, 2016b).

The core idea of the blockchain technology is consequently the fact that it is accessible for everyone, but still controlled or possessed by no user alone. It is with the help and co-operation of the participants of the network that keep the ledger in accordance with present time. The participants together enhance and continue the blockchain by complying strict rules and general agreement, which mean that the participants agree on how the chain will be updated. (The Economist, 2016b) This agreement is called 'the consensus mechanism' (The Economist, 2015).

The technology functions via a peer-to-peer network, which is based on thousands of 'nodes', e.g. computers, worldwide (The Economist, 2015). Nodes can come and go as they please in the network (Nakamoto, 2008). New blocks are born via a process called mining by specialized nodes, or in other words miners. These miners operate anonymously by working together and trying to solve mathematical puzzles, which creates new blocks to the blockchain. This creation is not as simple as it may sound. It takes several steps to accomplish and confirm a new block. In currency transactions, multiple miners verify the transactions and supervise that

everything is in order and that the person making the transaction actually has the money (s)he wants to spend. If it is a valid transaction, the miners confirm the change. Hereafter similar transactions are in a chronological order bundled in the same block, which in the longer run forms a chain of blocks. (The Economist, 2015) The chain contains all of the accepted transactions that has occurred since the birth of the blockchain (Peters & Panayi, 2015) and the information is available to all at any given time. Peters and Panayi (2015) have referred to the blockchain as a chronological ledger, or a database in which transactions are recorded by a network consisting of computers.

Figure 1: The Merkle Tree



Modified from The Economist (2015)

Every transaction has an identifying code, known as a hash, which contains the original piece of information of the transaction (The Economist, 2016b). The hash values of the transactions that are bundled together in a block, are combined in a system called 'the Merkle Tree' (see figure 1). This combined hash value is put into the header of a new block additionally with some other information, such as the hash of the previous block (see figure 1 'Block 10 #') and a timestamp. The previous hash in the new block ensures that the blocks are not tampered with and hinders cheating. (The Economist, 2015) The timestamp on the other hand proves that the data existed at the time being (Nakamoto, 2008).

Afterwards the header becomes part of a mathematical puzzle, which miners solve by manipulating a certain number called a 'nonce' (The Economist, 2015). The miners go through trillions of possible solutions to solve the puzzle and when the right solution is found, the miner who finds it, announces it to the others in the network (Nakamoto, 2008). The other miners check the solution and it if it is correct they confirm it and update the block correspondingly (The Economist, 2015). This is the beauty of the blockchain – the puzzle is hard to solve, but simple to check. The hash of the header is the identifying string of the newly mined block, which is now part of the blockchain. (The Economist, 2015)

In return for mining new blocks and maintaining the blockchain, miners receive rewards of a certain amount of newly mined bitcoins (The Economist, 2016b). In October 2015, the amount was 25 bitcoins per mined block, which corresponds to $7.500 (Böhme et al., 2015, The Economist, 2015). This is the incentive why miners are willing to update the blockchains by solving difficult puzzles. The payment can also be postponed until a certain amount of blocks have been mined (The Economist, 2015). This secures that the miners more efficiently maintain the blockchain. The postponement is enabled by smart contracts, which are explained in chapter 2.4.1. (The Economist, 2015) An alternative reward system is adding transaction fees to the transactions (Böhme et al., 2015). In 2014 97 percent of the transactions included a transaction fee, which is currently less than 0,1 percent of the transaction value. This reward system is necessary, since it is a sufficient incentive for the miners to continue maintaining the blockchains when the last bitcoins are mined and no more bitcoins can be received as a reward. These transactions fees are marginal in comparison to traditional transaction costs, but they tend to rise when the last bitcoins have been mined. (Böhme et al., 2015)

2.1.1 How to maintain the security of the blockchain technology

Even though the blockchains are publicly available, they are secure and reliable (The Economist, 2015). There are according to The Economist (2015) at least two factors that increase the security of the blockchain. First, the reliability is associated with chance. No one can predict which miner will update and solve the puzzle next or at any given time. Second, reliability is enhanced because of history. An attempt to tamper with the transaction history will stick out and as a result, the hash value of the tampered block becomes different and does not match the following blocks anymore (The Economist, 2016b). Furthermore, miners are continuously keeping an eye on the transactions and refusing to accept transactions that do not look coherent.

In fact, to be able to tamper with the blockchain you should be a master miner. If someone would try to rewrite history, this person would need to know how to solve an extremely difficult mathematical puzzle to create a new block. In addition, (s)he should be able to lengthen the new blockchain faster than the original

chain is lengthened by the rest of the network. If the cheater would succeed in building the chain faster than the non-cheating miners, the others would start to work on the counterfeited chain since miners are always working on the longest chain. However, this is almost impossible because it is very unlikely that the cheater would create a new block starting from the block that is modified and lengthen the new chain at the same time or even faster than the miners lengthen the original chain. (The Economist, 2015) Nakamoto (2008) emphasized in his study that to change history in one block requires redoing all the blocks after it. Thus, history and chance make cheating extremely difficult.

2.2 Bitcoin versus blockchain

The blockchain technology's most known application is bitcoin. Therefore, this thesis analyzes concisely the possibilities of bitcoin to serve as an alternative currency. There is a need to emphasize that the blockchain technology has more significant uses than bitcoin and it has also been claimed that bitcoin is in fact a poor application of the blockchain technology (The Economist, 2016b). The thesis goes through several alternative uses for the blockchain in chapter 2.4.

The efficiency of bitcoin has been argued a lot and there are conflicting opinions and theories about its capability to serve as an alternative to fiat currencies. In order to work in the same way as cash, double spending of bitcoins has to be prevented. Furthermore, bitcoin has to be a medium of exchange. All of this has to be managed without involving a trusted intermediary, such as a financial institution like a bank. (The Economist, 2015)

The blockchain underpinning the currency ensures with the help of its strict mining process and consensus mechanism that bitcoins cannot be used more than once. This is a requirement in order to have a correctly functioning currency without an intermediary. Therefore, instead of having a financial institution to confirm and secure currency transactions, the blockchain itself functions as proof. (The Economist, 2016b) The original idea of Nakamoto (2008) behind bitcoin was to question the need of an intermediary in transactions. Thus, this virtual payment system is based on "cryptographic proof instead of trust" (Nakamoto, 2008).

In other words, bitcoin has certainly an opportunity to challenge fiat currencies, since two of bitcoin's most appealing attributes are that it minimizes transaction costs and cheating. It is also the most dominant virtual currency of 500 others (Trautman & Harrell, 2016). Nonetheless, it faces some complications as well. The value of bitcoin is unstable and unpredictable, which makes it a rather unappealing currency (The Economist,

2015). Another major issue of bitcoin is that it is often connected with drug dealing and blackmailing (The Economist, 2016b). The technology enables the users to transfer money and operate anonymously, which as a result lead to suspicious utilizations (The Economist, 2016b). This is why bitcoin is a poor application of the blockchain technology.

Most of the stored data in the current blockchains are bitcoins, but the technology has all sorts of applications beyond virtual currency (The Economist, 2015). It has the possibility to reshape not only the policy of the financial sector, but also in other areas. Guadamuz and Marsden (2015) claim that bitcoin may be "overhyped and poorly executed", when blockchain on the other hand is "a truly transformative social technology".

2.3 The challenges of the blockchain technology

Even though blockchain technology is believed to revolutionize the ways of doing business, the change from the way business is done today to a blockchain-based system will take time. A widespread use of the technology is believed to take at least up to ten years (The Economist, 2016a). In addition, today's utilization of the technology is very limited compared to the use in a few years. It is possible that if this technology would be implemented worldwide with millions of users, it could not support all the services securely for all.

The blockchain technology confronts both technical and legislative barriers. The creation of new blocks to the blockchain have a negative impact on the environment. The mining process consumes vast amounts of electricity and mining equipment every time a new block is created or a transaction verified (The Economist, 2015). This burns continuously raw materials and energy (Narayanan et al., 2016). Even all the trillions of efforts to solve the difficult puzzles waste energy (The Economist, 2015).

The more people use blockchain-based programs; the more energy is consumed. In October 2015, The Economist (2015) pointed out that if miners use the most efficient technology, the electricity usage could take up to two terawatt-hours per annum. This corresponds to the electricity usage of a little more than 150.000 inhabitants in California (The Economist, 2015). Therefore, a secondary use for the wasted energy and a more environmentally friendly mining process are required. There is in fact another alternative to the mining process. Virtual mining can replace the process of solving mathematical puzzles by hand, which also reduces the need of equipment (Narayanan et al., 2016). This is argued to decrease the "environmental footprint" caused by the mining process and even more importantly, to ensure that the mining is performed by those stakeholders who have the system's best interest at heart (Narayanan et al., 2016).

Moreover, the blockchain technology can also be used improperly. One way to abuse the system is a so-called 51 percent attack. This means that someone controls over half of the network, thus 51 percent, so that transactions cannot be verified as they should be and as a result false information can be added to the blockchain (The Economist, 2015). This is extremely unlikely due to the massive size of the network. However, there is another way to mislead the system. Whether the very first piece of information added to the blockchain is false, it can make the system believe that it is legitimate.

There are also legislative barriers of which one is regulation. Stricter regulations can hinder the development of the blockchain technology. Thus, before we know the whole potential of the technology, it would be a mistake to strengthen the regulations too tight of institutions where the technology can be applied (The Economist, 2016b). Another issue that the technology encounters is people who are reluctant to change (The Economist, 2015). Industries that rely on trust, such as financial institutions, are affected the most by this technology. Even though several financial institutions are working on ways to adapt this technology, others will surely fight against it. It may not be appealing to suddenly change from a system where a company or a bank maintains personal and confidential information to a system based on proof that is controlled by no one (The Economist, 2015).

Meeting these challenges require an agreement throughout the whole community. Only then a thorough adaption of the blockchain technology will be possible. (The Economist, 2015) The fact is that a decentralized system based on a distributed ledger may be as trustworthy as the current centralized one, perhaps even more trustworthy.

2.4 Possible applications of the blockchain technology

As this thesis already acknowledges, blockchains are not only restricted to bitcoin. All sorts of immaterial assets can be recorded and transferred in blockchains (The Economist, 2016b). It is therefore essential to differ between the specific technology behind the virtual currency bitcoin and the general idea of blockchains. The blockchain of bitcoin hinders from double-spending bitcoins and enables users to operate anonymously. However, blockchains can have other features as well. Meanwhile bitcoin may remain as a fad, the blockchain technology in general has a notable number of other uses. (The Economist, 2016b) Instead of being used as a platform for running a virtual currency, the blockchain technology could be applied to information storage (The Economist, 2015).

Several applications of the technology have been established by now. These applications include smart contracts, blockchain-based securities trading and blockchain-based land registries, to mention but a few. This thesis will further explain how to utilize the blockchain technology in these specific areas. In addition to these three applications, the technology can be adapted to several purposes only within the financial sector, which are introduced in chapter 3.

There is still little knowledge of what this technology will exactly enable, but it has great potential to transform how the economy work and specifically to disrupt industries that rely on trust.

2.4.1 Smart contracts

This application is believed to be the most ambitious (The Economist, 2015). The key idea of smart contracts is that terms and information can be put in to a contract and if the terms realize, the contract executes automatically (The Economist, 2016a). However, if the terms are not fulfilled, the contract does not come into effect. The possibility to embed information into blockchains enables making secure contracts between individuals that do not need confirmation by a third party. Additionally, neither party is able to violate the terms of agreement in a smart contract (Pinna & Ruttenberg, 2016).

Smart contracts can be adapted in all sorts of contracts; bitcoins can be executed within the right circumstances and organizations can program into their contracts that they automatically pay dividends to their stakeholders if and when a certain level of profit is reached (The Economist, 2015). These smart contracts revolutionize the way contracts are made today by making them cheaper when the need of an intermediary to verify the contracts is eliminated and more reliable. The reliability is enhanced by one of the blockchain's key features, namely the fact that it is tamperproof. (The Economist, 2015)

2.4.2 Blockchain-based securities trading

Malinova and Park (2016) explain in their study how the blockchain technology can be utilized in designing and structuring the securities markets. They have listed the features of the blockchain technology that enable designing the markets in a new way, compared to today's securities trading. One of these features is the "electronic nature of blockchain securities" (Malinova & Park, 2016). The blockchain securities are technically based on smart contracts. The technology allows the investors to put information and trading rules in to their blockchain securities (Malinova & Park, 2016). These trading rules can include certain conditions, such as

price requests, which if fulfilled, the trade executes automatically. If the terms do not realize, the security does not change owners.

Another feature of the blockchain securities is that they enable investors to contact each other directly in the securities markets, without going through an intermediary. In the current securities market, most of the trading happens via a third party. However, it is still unclear how the blockchain technology will affect the trading markets in the long run. (Malinova & Park, 2016)

2.4.3 Blockchain-based land registries

The blockchain technology can be utilized to implement a public and tamperproof database for land registries. This could especially benefit corrupted countries where land registries are badly kept. (The Economist, 2015) Land registries consist of information about property rights, such as registered estates and interests in land. They increase security in many ways (The Economist, 2015). On one hand a blockchain-based land registry increases security, because it makes it impossible to illegally change ownerships of property rights, which is usual in corrupted countries. On the other hand, properties can be used as collateral. A worthy collateral enhances the chance of receiving a loan, which increases the possibility to invest. (The Economist, 2015) This is essential for a functioning economy.

Besides property rights, the blockchains can contain information about ownership of artworks and luxury items (The Economist, 2016b). The company Everledger began to use the blockchain technology to prevent theft of diamonds by putting data about diamonds' characteristic attributes in the blockchains (The Economist, 2016b). In fact, any piece of information of value can be stored in these trustworthy ledgers (The Economist, 2015).

3. The blockchain technology and the financial sector

In the previous chapter the thesis has explained the core concepts of the blockchain technology and its most ambitious applications so far. However, the aim of this thesis is to give an insight on how this new and disruptive technology will revolutionize and reshape the financial sector. Therefore, the purpose of this chapter is to introduce possible applications of the technology in the banking world. Since the blockchain technology has only recently gained attention, the amount of research on the effects of the blockchain technology in the financial sector is limited. For this reason, many of the conclusions in this chapter are made in this thesis.

3.1 The disruptive changes in the future financial sector

The financial sector, and particularly the banking sector, is regarded as a strictly regulated and conservative branch and its revenue model has been unchangeable for a long time. Nevertheless, new and advanced technology will shape the banking sector heavily in the next ten years (PWC, 2014). In order to adapt to these changes, financial institutions need to become less reluctant to these new technologies that transform ways of doing business.

There are conflicting opinions on how the blockchain technology will affect the financial sector. The most extreme hypothesis is that the blockchain technology makes banks unnecessary. It is undeniably an extreme claim that the whole banking sector would disappear because of the technology. Therefore, this thesis argues that the financial institutions are more likely to take advantage of the blockchain technology than to become obsolete because of it. However, some old ways of doing business may become obsolete or reshaped. Cryan (2016) for instance claims that cash will not exist in ten years. It is likely that many services that banks offer are disappearing, but new services are being invented at the same time. As Murray (2016) has stated, the blockchain will for sure kill some of the jobs in the financial sector, but it will simultaneously create new ones.

As this thesis acknowledges, the blockchain technology has great opportunities to reshape entire industries, especially those that rely on trust. Consequently, the financial sector can benefit from the new technology since it is an industry that depends highly on trust. Nevertheless, the blockchain technology meets resistance from people who are reluctant to change as well as technological advancements (The Economist, 2015). However, due to the decrease in confidence and transparency in the financial system, a technology that functions as a trust machine cannot only be a bad thing (The Economist, 2016b).

The blockchain technology can thus create faith in the financial system. This is an important aspect especially from the perspective of financial institutions. When people trust in the financial markets, financial institutions can more efficiently concentrate on their main assignments, such as transferring resources from lenders to borrowers. However, if they expect that a bank will fail, it can cause bank runs and one bank's failure can transmit to another, which leads to chaos in the financial system (Diamond & Dybvig, 1983).

Except that the technology functions as a trust machine, the financial sector can benefit from the blockchain technology in other ways as well. Thanks to the digitalization trends and the development of computing, financial institutions have been able to reshape their inner workings and digitalize most of their products and services (The Economist, 2015). Nevertheless, the organizations of the banks are still lagging behind the digitalization and are mostly centralized. Payment systems and the double-entry book-keeping between banks are both centralized systems even though the blockchain technology could achieve a higher degree of synchronization in these specific areas. For instance, payment transactions are often required to go through a trusted intermediary. (The Economist, 2015) A deeper synchronization improves efficiency, reduces risks and cuts down on expenses, which will soon be indicated.

Additionally, a throughout implementation of the blockchain technology in the financial sector demands cooperation between all actors involved. This is a challenge in the highly competitive world of finance. (The Economist, 2015) Thus, it is without no doubt that the competitive nature of the financial institutions will transform remarkably there where blockchains are put into practice. The thesis explains further in chapter 3.3 how exactly the competition between the actors is going to change by using the Distributed Ledger Group as an example.

The blockchain technology has tremendous potential to disrupt the current financial system, but in order to do so, the technology needs to be developed and backed up by financial institutions to avoid becoming only a fad as bitcoin threatens to remain (Stafford, 2015). Stafford (2015) argues that a relevant application of the blockchain technology has to be delivered to the financial sector in 18 months or the hype about blockchains will fade.

3.2 The benefits of the adaption of the technology

It is no wonder that the banking world is excited about this relatively new technology, since it has the ability to enhance efficiency and cut down on expenses. The blockchain technology is from an economic perspective

all about minimizing waste and increasing assets in companies. The Spanish banking concern Santander has even claimed that by the year 2022, the blockchain technology can save up to $20 billion a year in the banking industry (The Economist, 2015). Even so, the excitement of the blockchain technology is a bit ironic, because it was the failures of the financial sector that inspired Nakamoto to invent an optional currency in the first place (The Economics, 2015).

Nakamoto (2008) argues that the traditional banking system limits the access of information to only those involved and the intermediary, thereby achieving its privacy level. The traditional system plays thus a great part in securing all parties and holding on to information. The intermediary increases the transaction costs, which on the other hand limits the smallest possible size of a transaction and makes casual transactions less attractive (Nakamoto, 2008). The possibility to transfer transactions in blockchains without a trusted intermediary reduces the transaction costs and thereby does not limit the smallest possible transaction sizes.

Financial institutions should implement the blockchain technology to automate international payments and securities trading to begin with. In the banking system of today international payments can take up to several days to reach their destinations and furthermore, they can be costly procedures. With the help of blockchains, these kinds of payments can be transferred instantly or in a few minutes with minimized transaction costs (Pilkington, 2015). However, these payments cannot be anonymous like in bitcoin transactions, since they have to be traceable. Thus another type of a blockchain is required to be used in similar transactions to increase transparency.

As already mentioned in the previous chapter, also a blockchain-based securities market could be more efficient when securities are traded without unnecessary intermediaries. Then less capital is bound in transactions and thereby the amount of risk is reduced (The Economist, 2016a). The current trade-and-settlement process is in fact rather dated as well. It is a complicated procedure, where the money changes owners faster than the ownerships of the securities do. In blockchains, securities can be traded every hour of the day and securities change owners instantly, which improves the trade-and-settlement process. Malinova and Park (2016) claim that blockchain-based trading should be seen as an enhancement, which increases the efficiency and reduces costs of the trade-and-settlement process.

Another area where the blockchain technology is applicable is the double-entry book-keeping between financial firms. Instead of having own records of assets, the banks would have a decentralized database, which would increase the synchronization between all involved (The Economist, 2016a). As a result, banks do not need to monitor their assets separately in different databases, as they do today, but everything would be recorded in one. A blockchain-based shared database does not tie up as much capital as internal ledgers do, since coordinating the banks' internal ledgers can take up to several days and therefore reduces risks. (The Economist, 2016a) In a decentralized database information is up to date, which improves efficiency when

capital is no longer unnecessarily tied up and can be utilized more efficiently. However, it is certainly not a problem free solution. If there would be a shared ledger, who would have the right to observe and update the ledger and how would the banks ensure that the information in the ledger is correct (Brown, 2015)? These are questions that need to be answered before a shared ledger can be implemented.

As previously stated, smart contracts can be applied in various types of contracts. Many of today's contracts made e.g. between a financial institution and a customer can be updated to private contracts between those involved (The Economist, 2015). For instance, a loan agreement can be put in to and confirmed in a block-chain. When certain conditions are fulfilled, the customer receives the loan and neither party can violate the agreements made in the contract. Smart contracts can be applied to automatic transactions as well (Pinna & Ruttenberg, 2016). Assets can be transferred from one account to another and coupon payments as well as dividends can be payed automatically (Pinna & Ruttenberg, 2016). Pinna and Ruttenberg (2016) state that the smart contracts can especially disrupt the post-trade market, since they could replace several functions that are at present time maintained by necessary post-trade institutions.

Simultaneously as the smart contracts enhance all sorts of processes they also reduce costs, since an intermediary is not required to verify the contracts separately. This enables e.g. transferring instantly and automatically loans if the terms are fulfilled without any arrangement fees or transaction costs. This may potentially increase the competitiveness of financial institutions that offer these sorts of contracts.

In addition to reducing risks and expenditures, the blockchains also minimize errors along with fraud (The Economist, 2015). In the traditional payment system, a small but certain amount of fraud is accepted since it is regarded as unmanageable (Nakamoto, 2008). In blockchains, fraud is not accepted at all and therefore it could enable a more trusted and secure system than the traditional banking system of today is.

Be that as it may, in the world of today criminals have also begun to conduct in a much different way than before. Hackers have replaced bank robbers and commit nowadays crimes by using new technology from all around the world without physical interactions (Bryans, 2014). As a result, money-laundering has become more difficult to recognize by bankers when most of today's money is circulating online. Money-laundering is the process where illegally gained money is made to look purified (Bryans, 2014). As a result, regulation has tightened in the banking world. These regulations include anti-money-laundering and knowing your customers, which means that it is even more important to know how customers behave. The blockchain technology allows to obey to these regulations, since every transaction from the inception of the blockchain is resistant to tampering and public to all, which increases transparency (The Economist, 2016a). Due to stricter regulations, private blockchains have recently gained attention as well by the banking world (The Economist, 2015).

There is a distinction to be made between public and private blockchains. They should be seen as two different types of blockchains that serve to solve different problems (Pilkington, 2015). The main difference between these two is the access permission to the information in the blockchains (Buterin, 2015). Private blockchains control more tightly the permission to access the information and the right to alter the blockchains or even read the records. Even though the private blockchains are more restricted than the public blockchains, they still maintain the guarantee of reliability. (Buterin, 2015) Financial institutions are especially interested in these private blockchains because of the possibility to store confidential information securely while controlling the access to the information (The Economist, 2015). The information and terms in private blockchains are also easier to change afterwards than in public blockchains, since someone is in control. Transactions and contracts of any kind are almost impossible to modify or cancel after they have been verified in public blockchains. (Buterin, 2015)

As one can see, the blockchain technology has the potential to enable several and very different types of applications in the financial sector and it is most likely that it will in the near future enable even more. So far it is difficult to tell what sorts of applications will be applied eventually and to what extent. It is important to emphasize that it is not reasonable to put everything in blockchains, because there may be some services more suitable for the blockchain technology than others. Therefore, it is extreme to claim that the financial institutions would disappear because of the blockchain technology. Even though it would be possible, it is not necessary to use blockchains to everything.

3.3 The Distributed Ledger Group

The blockchain technology is a promising instrument to disrupt the whole banking sector (The Economist 2016b). This has been acknowledged by the Distributed Ledger Group, which was founded in September 2015 by a group of banks from around the world and the American start-up R3. In the beginning there were only nine banks part of the Distributed Ledger Group, but rather fast more banks joined and currently approximately 50 financial institutions are part of the group. There are four Finnish banks involved in this Distributed Ledger Group including Danske Bank, Nordea, Osuuspankki and SEB. (R3, 2016)

The purpose of the co-operation between the start-up and the financial institutions is to enhance as well as fasten the development and utilization of the blockchain technology to the financial sector. Together they are trying to come up with shared standards and to form a blockchain partnership (The Economist, 2016a).

They invest in the development of the technology, identify areas where the technology could be employed and even define new markets that do not even exist (The Economist, 2016a).

One of the reasons why this co-operation is of great significance in order to successfully apply the blockchain technology to the financial sector is because several of the possible applications require co-operation and shared standards between the rival financial institutions. Shared standards are rare and a challenge in the highly competitive world of banking, but are in fact a requirement to enable an implementation of the block-chain technology to the banking sector (The Economist, 2015). Instead of competing and working apart from each other they need to work and face the complications together.

Even though shared standards may seem like a problem due to commercial secrets and competition, banks are looking mostly for applications that can be utilized mutually. It makes more sense to have one shared payment system that every bank uses, than every bank having an own expensive system. In fact, it is possible that a bank would not even benefit from having an own blockchain, since the benefit comes from the amount of users. Hence the more banks are using the blockchain technology, the more the banks gain from it. At least small and medium-sized financial institutions would seem to take advantage from this Distributed Ledger Group, since they often have restricted resources and possibilities to invest in new technologies.

Besides the Distributed Ledger Group there are many start-ups trying to make a financial breakthrough by using either the blockchain of bitcoin or creating new blockchains to come up with new and disruptive ways of doing business (The Economist, 2016b). A company named Ripple has with a bunch of banks started a co-operation to reduce the costs of international payments. NASDAQ on the other hand plans on launching a “blockchain-based e-voting service” for companies’ shareholders in Estonia. (The Economist, 2016a)

4. Conclusion

The purpose of this thesis was to examine the blockchain technology's possible applications in the financial sector and to highlight the importance and significance of the technology. As this thesis acknowledges, the blockchain technology is not only restricted to the virtual currency bitcoin, but is applicable to much more. In fact, this thesis indicates that bitcoin is a rather poor application of this technology, since it enables the users to transfer money and operate anonymously, which as a result lead to suspicious utilizations (The Economist, 2016b). The blockchain technology has several other applications and these have been introduced throughout this thesis by using existing literature.

The financial sector can benefit from the blockchain technology in many ways. The technology can reduce costs and increase efficiency when unnecessary and costly intermediaries are eliminated from different processes. The blockchain technology reduces also risks when less assets are tied up during transactions (The Economist, 2016a). Transparency is enhanced thanks to the distributed characteristics of public blockchains and security is confirmed when information cannot be tampered with (The Economist, 2015). Recently private blockchains have gained attention especially in the banking sector, since they enable storing confidential information and controlling the access permission to the information in the records (Buterin, 2015).

Malinova and Park (2016) have in their study examined blockchain-based securities trading and find that market design can be reshaped by applying the blockchain technology. Pinna and Ruttenberg (2016) on the other hand claim that smart contracts have the ability to replace several functions in the financial markets that are currently maintained by obligatory post-trade intermediaries. Pilkington (2015) finds that international payments can be transferred in blockchains in only a few minutes, which is significant comparing to today's system where it can take up to several days until international payments reach their destinations. However, as this thesis has pointed out, international payments cannot be transferred anonymously as in bitcoin transactions, but need to be traceable. Therefore, another type of a blockchain has to be applied in these sorts of transactions. This thesis argues that financial institutions should to begin with implement the blockchain technology to automate international payments and securities trading, since these have already been applied to some extent using the blockchain technology.

As one can see, the blockchain technology enables several and very different types of applications only within the financial sector and will enable even more in the near future. So far, it is difficult to tell what sorts of applications will be applied and to what extent, since the blockchain technology is still in its early stage of development. It is also important to emphasize that there might be some services more suitable for the blockchain technology than others. Therefore, it is questionable to claim that the blockchain technology could kill the financial sector.

Since the blockchain technology is a rather new technology, there is plenty of room for more research in this topic. This thesis focused on the effects of the blockchain technology in the financial markets and what sorts of applications it could enable. There is however many different but interesting topics regarding the blockchain technology to study. One interesting area of research is how the blockchain technology will change the lives of 'normal individuals'. One thing to be sure about is that banking services will become faster and cheaper, which means that everyone who has an account or is involved with business online is going to be affected by this technology. This is in my opinion a very intriguing and current topic, but was narrowed down from this particular thesis. Another relevant topic is the co-operation of the Distributed Ledger Group. One could study the progresses and developments achieved by the Distributed Ledger Group and more in detail examine the possibilities the blockchain technology has in the financial sector.

There are still technical and legislative barriers to overcome before shifting to a blockchain-based system. There is no doubt that the blockchain technology will have significant meaning in the long run, but it will take time until it has reached its full potential. As Masters (2015) has claimed about the implementation of the blockchain technology to the financial sector: "we won't get there overnight, but we will get there".

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